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May 4, 1989

Ref: 1091C/890502

US EPA, Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101

Attn: **Mrs. Alice Fuerst**

Re: **Field Operations Plan - Cherokee County**

Dear Mrs. Fuerst:

Attached please find the Field Operations Plan for the field characterization portion of the pilot leach testing program being undertaken by the participating PRP group.

The FOP has been reviewed by Mr. Jerry May of CH2M Hill, whose comments and suggestions I have already incorporated. The FOP is closely modeled on one developed by CH2M Hill for an earlier field program performed for you. Copies of the plan will be available in the field at all times.

I trust that you will find this letter and the attached Field Operations Plan acceptable. If you have questions about this letter or our FOP, please contact me directly. Outside of MDT business hours, you or your staff may contact me by telephone at 303/322-2399.

We anticipate being ready to begin field characterization during the week of May 15, 1989. Thus, we would greatly appreciate your reponse to our submissions and an indication that the CH2M Hill work plans also have been approved, so that we may finalize our logistics and procede with this effort.

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REMD SECTION

Nothing in this letter is to be construed as altering the terms or conditions of the Professional Services Agreement between Adrian Brown Consultants, Inc. and the Participants (Amax Mineral Resources Company, NL Industries, Gold Fields American Corporation, ASARCO, and Sun Company, Inc.). Because Adrian Brown Consultants is an independent contractor, the firm is not authorized to speak on behalf of the Participants with respect to any matters outside the scope of the current agreement. In particular, no statement by Adrian Brown Consultants or any of its employees or subcontractors may be considered an admission or waiver of any defense by any or all of the PRPs concerning liability for response costs or concerning the propriety of U.S. Environmental Protection Agency's actions at the Cherokee County site as a whole or the Galena subsite in particular.

Sincerely,
ADRIAN BROWN CONSULTANTS, INC.

Mark J. Logsdon, Project Manager

cc: K.R. Paulsen (AMAX)
B. Sams (NL)
A. E. Godduhn (Gold Fields American)
J. Richardson (ASARCO)
L. Grossi-Tyson (Sun)

FIELD OPERATIONS PLAN

Field Characterization, Galena Subsite
Pilot Testing Program
(EPA Ref: 223-7L37)

May, 1989

Prepared by

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1091C/03

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1.0 INTRODUCTION

This Field Operations Plan (FOP) is for the field characterization sampling episode for the PRP Participants' Pilot Testing Program, to be conducted in May 1989 at the Galena Subsite of the Cherokee County Superfund Site in Kansas. This investigation will provide technical assistance to support design development of a portion of one of the proposed remedial for the Groundwater and Surface Water Operable Unit. This work has been authorized via the approved Technical Assistance for Galena Subsite Mine Waste Characterization, Work Plan Revision Request No. 3, dated April 14, 1989.

As defined in the Galena Subsite Groundwater and Surface Water Operable Unit Feasibility Study (OUFS) (EPA 1988), wastes from mine shaft and mine workings excavation, ore stockpiling, and minerals processing were deposited in numerous locations on the surface of the subsite. It was determined that these mine wastes contain sulfide minerals (principally of lead and zinc), plus oxide, carbonate, and sulfate forms resulting primarily from the weathering of the sulfide minerals. These wastes are considered by EPA to be a potential public health threat as well as a contributor to metal contamination found in the surface streams and groundwater of the site.

The method of remediation proposed for study in this testing program includes disposal of coarse-grained surface and low-zinc chat wastes below the water table to the extent practicable. The remaining materials will be deposited underground, above the water table, to aid in backfilling some of the previously mined areas.

This FOP presents the sampling objectives, sampling procedures including tentative locations, sampling equipment requirements, and the field team organization and schedule. The Quality Assurance Project Plan (QAPP) for the Cherokee County Site has been amended for this field investigation (letter from M. Logsdon (ABC) to A. Fuerst (EPA), dated April 27, 1989) and is incoprporated in the FOP by reference. Several specific procedures which we anticipate using in the field characterization portion are described in more detail in the attachments to the FOP.

All field investigation activities will be subject to a site specific Health and Safety Plan to provide for the safe execution of field activities.

Site access approvals will be obtained by EPA prior to entering privately owned areas of the site. These approvals may be obtained before field investigations are initiated or as required during the course of the investigation.

2.0 SAMPLING OBJECTIVES

The objective of the field characterization sampling event is to collect mine waste and groundwater samples that will be used to select representative rock and water samples for use in the pilot test experiments. Chemical and physical data obtained in this phase will allow development of the most appropriate combination of design and operating parameters for the batch and flow-through tests.

The pilot leach tests will establish the expected geochemical response of leaching coarse mine waste rock and low-zinc chat with actual site ground waters. In addition to the geochemical data, the test program will provide data to be used in determining optimal practical size to be used in future screening and disposal activities and additional data on permeability of backfilled material and its possible impact on groundwater flow. It is considered that the testing program will provide important information for selecting a preferred remedial action at the Galena subsite.

The field characterization sampling described in this Field Operations Plan (FOP) will include vertical profiling of general water-quality characteristics (e.g., temperature, specific conductance, pH and dissolved oxygen) and collection of water-quality samples for chemical analysis. The purpose of this portion of the investigation is to identify and characterize groundwater sources that can be collected in bulk for use in the subsequent pilot leaching program.

Additionally, the field characterization sampling will characterize and select two types of mine waste rock (one siliceous and one calcareous), low-zinc chat, and local groundwater. Waste rock will be physically screened at nominal 2-inches for use in the testing program. Samples of both waste-rock types and the XRF-selected, low-zinc chat will be submitted for physical and chemical testing by a local subcontractor laboratory. Quality-assurance and quality-control testing will be performed, as described in the attached addenda to the QAPP. In addition, it is anticipated that about 10 percent of the samples will be collected in replicate by EPA Contractors for submission to a CLP laboratory for additional check analyses.

To meet the field characterization objectives, it is anticipated that up to 10 tons of reasonably representative, composited waste rock will be collected, sampled, and stockpiled in the field for use in subsequent phases of the pilot leach testing. Additionally, chat piles from the various EPA-designated mine waste characterization areas will be field sampled and tested with a portable XRF unit to characterize Pb and Zn concentrations. Based on this testing, a stockpile, probably comprising on the order of several tons, of relatively low Zn chat will be developed in the field for use in subsequent pilot leach testing.

3.0 SAMPLING PROCEDURES, LOCATIONS, AND EQUIPMENT

Waste characterization work was conducted by EPA and is found in Appendix D.5, "Mine Waste Characterization" of the Groundwater and Surface Water OUFS (EPA 1988b).

Characterization work by EPA contractors and/or PRP contractors included the identification and mapping of waste types; volume estimation; sampling at and near the surface; particle size analysis; EP Toxicity and Leach characterizations; and total metals analysis. Results and methodologies of these tasks have been taken into account during the design of this sampling program.

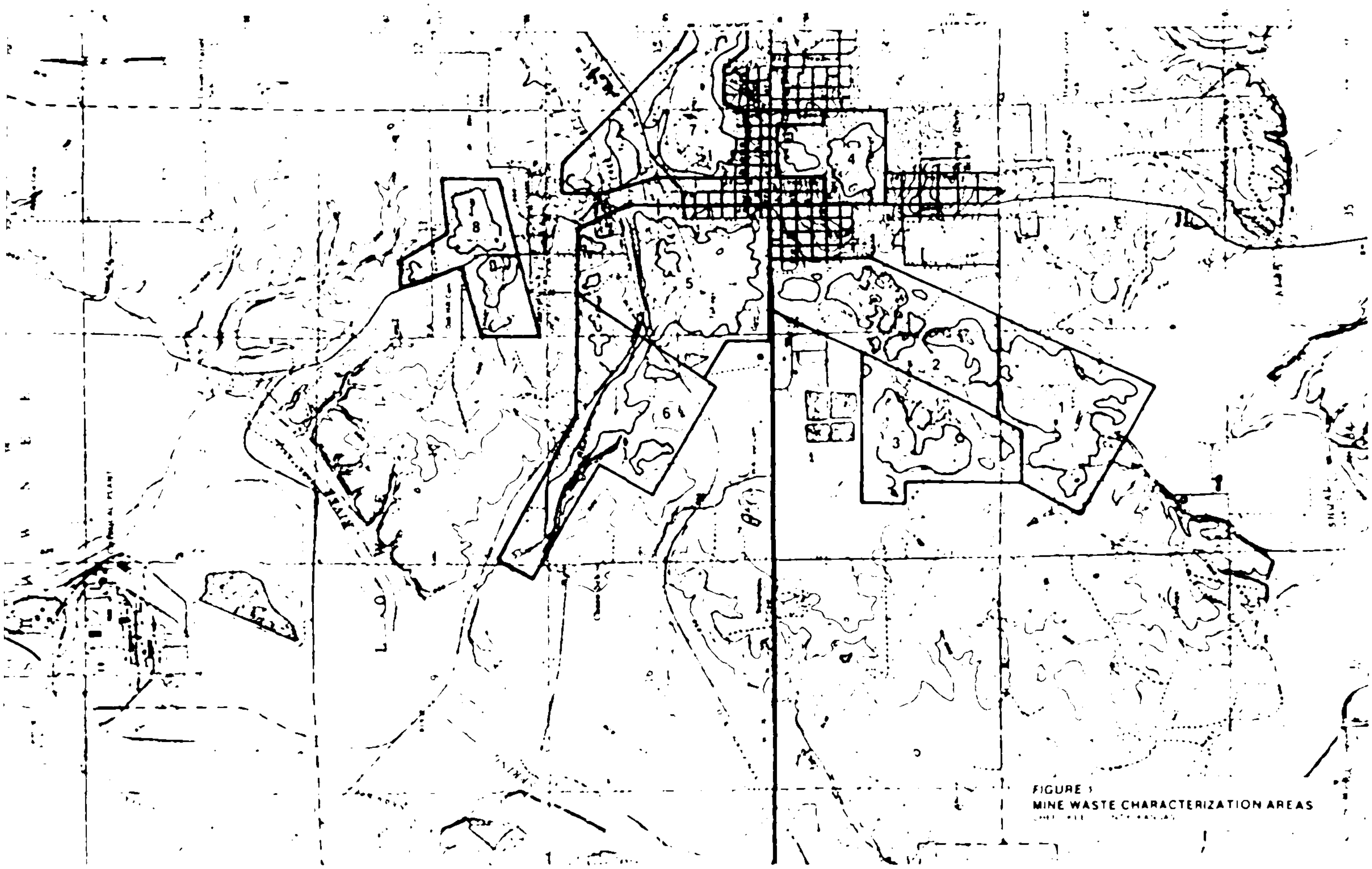
The surface mine waste areas within the Galena Subsite have been divided into 8 zones, as depicted in Figure 1. The total estimated volume of mine waste on the surface was estimated to be about 1,500,000 cubic yards. This volume of waste is distributed in many locations over approximately 900 discontinuous acres. Wastes in three of the eight waste zones failed the EP Toxicity test for lead (Zones 1,3, and 4), though subsequent column leach testing by PRPs showed that lead is expected to be largely insoluble when leached by rainwater.

3.1 GENERAL METHODOLOGY

Due to the large areal extent of deposition and heterogeneous characteristics of the mine wastes, it is very difficult to design an economical, statistically valid, bulk mine waste sampling program. To compensate for this difficulty, which is not uncommon in the mining industry, a parametric test method (varying design and operating parameters with waste-rock and chat zinc grade) for the pilot leach work has been developed.

Therefore, sample collection will be designed and reviewed in the field in order to collect representative silicious and calcareous waste-rock samples based primarily on visual identification of rock type and mineralogy. A portable X-ray fluorescence (XRF) spectrometer will be used with reference standards of galena (PbS) and sphalerite (ZnS) for semi-quantitative field measurements of chat materials.

FIGURE 1 Site Plan



Using maps and information from the previous field work, location, shape, and volumetric estimates of the waste piles by the PRPs will be the basis for determining exact sample locations. A minimum of 4 test pit locations per waste pile zone (a maximum of 8 zones) will be used. Samples from approximately four major chat piles will be collected and the samples will be analyzed with the XRF unit to identify low-zinc material suitable for testing in subsequent phases.

A backhoe will be used to develop trench samples to a vertical depth of up to 10 to 15 feet in the waste piles. Vertical horizons of varying mineral types will be measured for depth, and visual identification of waste-rock type and mineralogy on rock surfaces will be made for each test pit. A channel sample (top to bottom of equal width and depth) will be collected in proportion to the estimated total volume of the waste zone to be sampled.

Following sample collection activities, waste piles that have been trenched will be recontoured before completing the field activities.

3.2 INITIAL WASTE-ROCK STOCKPILING

Waste rock samples from piles selected and sampled in the field will be transported in trucks from sampling locations to a central stockpiling area at or near which the pilot testing will actually occur. Separate stockpiles for siliceous and calcareous waste rock will be developed and maintained. The haulage trucks will be clean, lined with plastic or other non-metallic material, and will be covered with tarpaulins while moving. Each truck load will be documented, with written descriptions in the field logbooks and ample photographs. Finally, the stockpiling at the central location will also be documented with maps, figures, photographs, and written descriptions, to allow a clear understanding of where and how the stockpiles were constructed and handled. As discussed in Section 2.0, above, it is anticipated that the total stockpiling of waste rock will include approximately 10 tons of rock.

3.3 WASTE-ROCK CHARACTERIZATION

Waste rock from each of the two (siliceous and calcareous) stockpiles will be physically screened at a nominal +2 inches and stockpiled. The +2 inch material will be used in the subsequent pilot leach testing, but samples of both sized fractions will be taken for chemical and limited physical testing, the results of which will be used to formulate the detailed design of the pilot leach tests. (In order to conduct a practical set of pilot leach tests, it is anticipated that +8-10 inch country rock will be hand cobbed from the waste-rock piles prior to final sampling and crushing.)

Sampling from the graded (+2 inch and -2 inch) waste-rock stockpiles for each rock type will be performed using a parametric approach analogous to that

originally used in the various waste rock characterization areas. As with the original sampling, detailed experimental design parameters will be selected and reviewed by both ABC and the EPA oversight team in the field to assure the collection of representative samples. A backhoe will be used to trench the graded stockpiles, forming a sampling sub-stockpile comprising approximately 1/4 the total volume of the original +2 inch and -2 inch stockpiles. These sub-stockpiles will be similarly quartered and requartered until samples of approximately 200 pounds of each rock type (with replicates, as appropriate) are selected.

The approximately 200-pound samples will be collected and stored in 5-gallon plastic buckets with lids for transportation to the selected testing laboratories. The sample containers will be sealed, maintained under chain-of-custody procedures, and transported to the testing laboratory.

At the primary (local) laboratory, the samples will be sieved into approximately 5-6 grain-size samples each, both to produce data on grain-size distributions and to allow subsampling for chemical and mineralogical analysis. Each of the sized subsamples will be crushed to -200 mesh, and these samples will be analyzed for total concentrations of Pb, Zn, Cd, and S by the local laboratory, as described in the Work Plan (Revision Request No. 3, April 14, 1989). Quality-control samples will be collected and analyzed, as well, and it is anticipated that splits of about 10% of the final -200 mesh sample produced at the local lab will be collected by the EPA oversight team and transported by them to a CLP laboratory for check analyses, as well. Additionally, samples will be selected by the ABC Field Program Manager (or his designee) in consultation with the EPA oversight personnel for XRD analysis of mineralogy.

3.4 CHAT STOCKPILING AND CHARACTERIZATION

Chat selected on the basis of Zn concentration as determined in the field by the portable XRF unit and stockpiled at the central location will be quartered and requartered similarly to the waste-rock samples. It is anticipated that the variously quartered samples will be field analyzed with the XRF unit to maintain documentation on the relative Zn and Pb concentrations during this phase of sample handling.

As with the waste-rock samples, approximately 200 pounds of chat will be collected in clean 5-gallon plastic buckets and transported to the primary laborarory for crushing to -200 mesh. Chain of custody will be maintained.

The crushed chat will be analyzed for total concentrations of Pb, Zn, Cd, and S by the local laboratory, as described in the Work Plan (Revision Request No. 3, April 14, 1989). Quality-control samples will be collected and analyzed,

and it is anticipated that about 10% of the samples will be collected in replicate by the EPA oversight team and transported by them to a CLP laboratory for check analyses, as well. Additionally, samples of chat may be selected by the ABC Field Program Manager (or his designee) in consultation with the EPA oversight personnel for XRD analysis of mineralogy.

3.5 GROUNDWATER CHARACTERIZATION

Based on previous, documented sampling and the initial field observations of the ABC field team and in consultation with the EPA oversight personnel, at least one flooded subsidence feature in each of the eight EPA-designated waste-rock characterization areas will be selected for characterization of water quality.

The initial characterization will be performed by vertically profiling the water at a point near the center of the feature using a Martek Industries Mark VII profiling unit, capable of determining temperature, pH, consuctivity, and dissolved oxygen. The profiling will be performed by a two-person team using a raft or boat. An addendum to the site-specific safety plan will describe the safety procedures considered appropriate for this subtask.

Based on the vertical profiling data, a specific sampling plan for the waters will be selected by the ABC Field Program Manager (or his designee) in consultation with the EPA oversight personnel. If discernible chemical/physical stratification is identified in the profiling phase, a stratified water-quality sampling approach will be required. It is anticipated that the stratified sampling would collect samples from approximately 30%, 50% and 80% of total depth, or such other intervals as may be indicated by the site-specific data and conditions. These water-quality samples will be collected using a stainless-steel or Teflon "thief bailer". Samples will be stored initially in properly labelled, inflatable cubitainers or equivalent containers. As soon as possible, the samples will be transferred to glass and plastic sample bottles provided by the local laborarory, filtered/preserved as appropriate, stored in insulated coolers (at a nominal 4 degrees C), and maintained under chain-of-custody procedures. The samples will be transported to the local laboratory daily, and quality-control samples will be shipped to the control laboratory daily, as well. It is anticipated that about 10% of the samples will be collected in replicate by EPA oversight team and transported by them to a CLP laboratory for check analyses.

3.6 DOCUMENTATION

Field logbooks, photographs, and other sampling documentation shall be maintained during all phases of the field characterization sampling episode to provide an adequate project record.

3.7 EQUIPMENT REQUIREMENTS

Stakes/flags
Tape measure
Shovels
5 gal buckets w/lids
Camera
Hand Lens
Field logbooks
XRF Spectrometer - to be provided by CH2M Hill
XRF Standards (galena and sphalerite) - to be provided by CH2M Hill
Water quality profiling unit - Martex Industries Series
Cubitainers
Laboratory-supplied sample bottles/preservatives
Laboratory-supplied insulated coolers
Field pH-conductivity meter
Field HCl
Raft
Backhoe
Sample documentation
Chain-of-custody
Field Operations Plan/QAPP
Site Safety Plan
Tarps
Site access approvals
Site access permission forms
Protective clothing

4.0 FIELD TEAM ORGANIZATION, RESPONSIBILITIES, AND SCHEDULE

The field team will consist of the following positions. A single individual may be responsible for more than one position.

- o Field Program Manager (FPM). The FPM will be responsible for day-to-day planning, scheduling, and execution of the sampling plan.
- o Site Safety Officer (SSO). The SSO will be responsible for enforcing the Site Safety Plan thoughout the field investigation.
- o Field Team Leader (FTL). The FTL is responsible for maintaining field log books, completing the documentation of all sampling activities, and gathering necessary equipment for each day's work.
- o Sampling Technicians. The samplers are responsible for proper collection and handling of the samples. They will work under the direction of the FTL.
- o Documentation Coordinator. The documentation coordinator is responsible for all aspects of sample documentation.

The field investigation activities described in this document are scheduled for May, 1989. It is estimated that the field sampling can be completed within one week.

The first day will be primarily spent obtaining the required equipment, identifying potential sampling areas, and confirming/obtaining site access approvals. Determining specific sample locations, based on field XRF measurements and waste type and volume, will be conducted during the second and third days. These locations will be staked and photographed for future reference. Sample collection, handling, and shipping will be completed during the fourth and fifth days.

5.0 REFERENCES

EPA 1988 Galena Subsite Groundwater and Surface Water Operable Unit Feasibility Study, Final Draft, Cherokee County Site, Kansas. February.

Section 15
X-RAY FLUORESCENCE SPECTROMETER

FIELD ANALYTICAL TECHNIQUES--X-RAY FLUORESCENCE SPECTROMETER

The chemical characterization of Quality Assurance/Quality Control (QA/QC) mine waste material in the field is proposed to be performed by the field potable x-ray fluorescence (XRF) spectrometer ATX-100 instrument manufactured by Aurora Tech, Inc, 331 Rio Grande Street, Salt Lake City, Utah. The instrument uses low level self-contained and shielded radioactive sources that produce spectrum of peaks which position (energy level) is specific to an individual element and peak height which is indicative of the concentration of that element within the area exposed to the source. Two sources are proposed to be used, cadmium-109 (15 millicuries) and americium-241 (19 millicuries) implaced by the manufacturer. The cadmium source will allow semiquantitative determination of the copper, zinc, arsenic, and lead concentrations. Additional elements that will be monitored include chromium, manganese, iron, cobalt, nickel, selenium, and molybdenum. The americium source will be used for the semiquantitative determination of cadmium and barium concentration.

Additional elements that will be monitored with the americium source include silver, tin, and antimony.

The detection limit for the instrument is a function of source strength, geometry/particle size, counting time, and the element concentration. Since the source strength and instrument geometry are constants, the detection limit is dependent on geometry/particle size, counting time, and concentration. It has been demonstrated that 80 mesh particle size dominantly composed of a siliceous or caleareous skeletal matrix will give analytical results within 20 percent. The larger the particle size, the larger the error. On a large mass the

larger the particles, the larger the error--a rock made up of fine-grained minerals, however, will essentially have the same precision and accuracy as a finely ground sample.

The counting time also affects the detection limit. In general, the longer the counting time, the lower the detection limit, and certainly the higher the precision and accuracy. The instrument has controllable time units of 10, 30, 100, 300, and manual control seconds. The 100 second counting time will likely be the standard for this test. This time should be low enough to x-ray pyrite as well as limestone and not exceed a total count level that will affect accuracy and precision. This rate may change for either or both sources depending on the actual sample matrix encountered in the field.

Experience with similar instruments with poorer resolution indicate that the semiquantitative detection limit can be expected to be below 10 parts per million on the five elements of primary concern. One to two parts per million is achievable but not with high precision. A suite of archived analyzed sample splits from earlier sampling of the tailings and soils will be used for calibration. They will be used to calculate a precision, accuracy, and detection limit. The samples will be scanned and the measurements recorded each day before the instrument is used.

The primary operator will receive one day's training on the proper use of the instrument particularly for health and safety purposes. The manufacturer's statement on radiation safety is also attached. The primary operator has over 5 years experience using similar instrument in field applications analogous to this application. The operator will have the dates and time used logged in the record book specifically kept for this purpose.

RADIATION SAFETY

Aurora Tech is licensed by the Utah Bureau of Radiation Control as an agreement state under the authority of the Nuclear Regulatory Commission.

The ATX-100 is manufactured under License UBRC-1800030 and is sold under the General License UBRC-1800031. This general license grants Aurora Tech the right to manufacture and sell the ATX-100 to unlicensed purchasers.

The ATX-100 user has available three sources for use in the sensor head, although only two will be installed in any one sensor head. The specifications of these sources are as follows:

	Fe-55	Cd-109	Am-241	Units
Initial Source Strength	100	15	19	mCi
Primary X-ray Energy	5.9	22.2	60	keV
Other Radiation	None	88 keV Gamma Ray	Alpha	
Half-Life	2.6	1.2	458	Years
Service Life	3-10	2-5	800+	Years

The radioactive sources employed in the device are sealed by the supplier and are leak tested before and after their insertion into the sensor head. It is extremely unlikely that Aurora Tech would ever sell an instrument with a leaking source of radioactivity. The purchaser has the subsequent responsibility for periodic leak tests. Any possible contamination would be identified by these tests.

According to measurements made by the Utah Bureau of Radiation Control under the authority of the Nuclear Regulatory Commission, the dose rate with the shutter closed at 5 cm. (about 2 inches) is about 4.1 mrem/hr.. and at 30 cm. (about 1 foot) it is 1.15 mrem/hr. A radiation worker is allowed 5,000 mrem/yr. total body dose and about 30,000 mrem/yr to the skin (each and every year). Therefore, a person would have to remain 2 inches from the sensor head for (30,000 mrem/4.1 mrem/hr. =) 7,317 hours or 305 days of 24 hours each or (5,000 mrem/.015 mrem/hr. = 33,333 hours) about 1,389 days of 24 hours each to accumulate his allowable annual dose. Obviously, it is doubtful that anyone would remain 2 inches away from the sensor head for 305 24-hour days and since there are not 1,389 days in the year, total body dose rate will not be exceeded.

Purposeful and biological significant exposure by a person by the radiological sources in the sensor head is possible, but this event seems quite unlikely since it would take a considerable time to accomplish. Because of the severe collimation of the direct radiation beam emerging from the instrument head, a total body exposure is impossible at a short distance. Also, it is not possible for a person to stand at more than an arm's length from the sensor head and still keep the shielding pulled back against the spring. This arm's length position would result in less than a total body exposure with the sensor head close to the body. The resulting maximum exposure rates might be about 6,000 mrem/hr. In order to accumulate 30 rem, the exposure time would have to be 5 hours. If the location of the exposure was not constant, the total dose received by any one volume of tissue would be greatly reduced. Therefore, a biological significant and purposeful, let alone inadvertent, exposure seems unlikely.

Exposure hazard from the ATX-100 is extremely small. This is because of the instrument design, quality control measures in manufacture, and the safety procedures inherent in ruggedness testing and the proper operation by suitable trained purchasers. Film safety badges will be used by the sample team for additional protection as described in the Health and Safety Plan.